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# **THE NATIONAL SHIPBUILDING RESEARCH PROGRAM**

## **1987 Ship Production Symposium**

### **Paper No. 8: Submarine Tank Repair Using Outfit Planning**

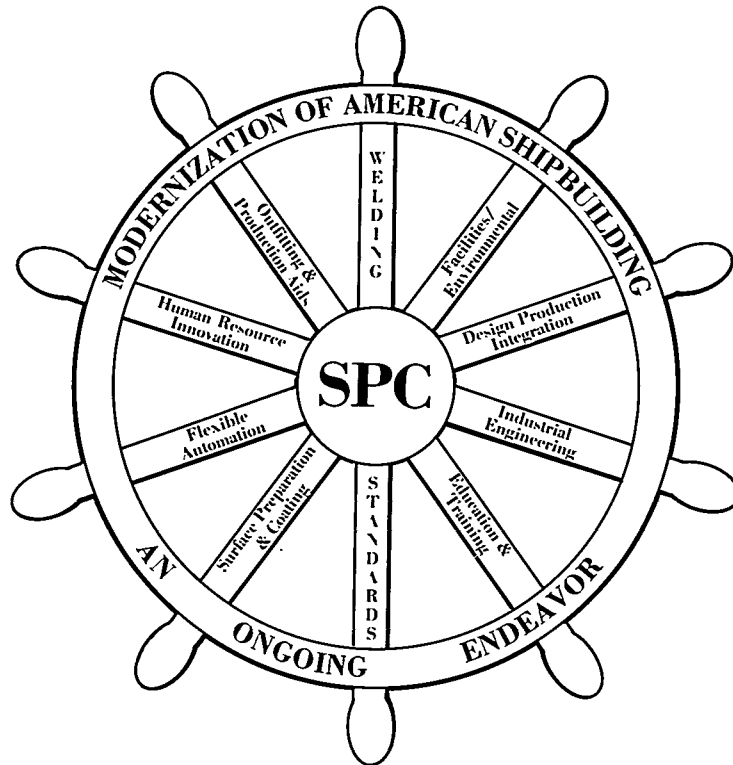
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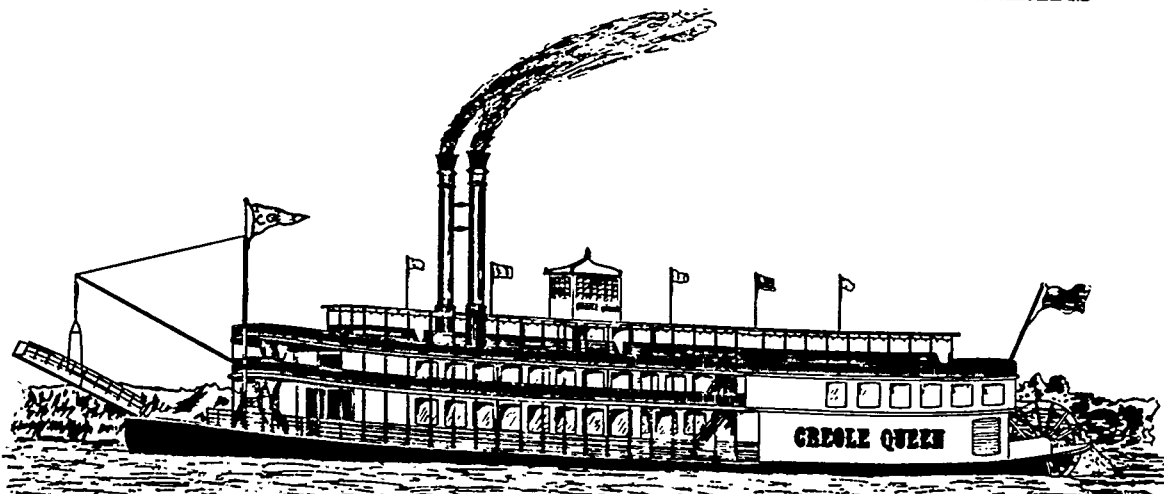
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AUGUST 26-28, 1987  
HYATT REGENCY HOTEL  
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## Submarine Tank Repair Using Outfit Planning No. 8

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### ABSTRACT

Outfit Planning and Zone Logic methods have been implemented in the Shipbuilding Industry in response to the need for increased efficiency in the construction of new ships. Efforts have been under way at Puget Sound Naval Shipyard to use Outfit Planning principles to plan and execute ship alterations on operational ships. The next logical step is to use these same principles to plan and execute overhaul and refurbishment work. This paper addresses efforts at Puget Sound Naval Shipyard to apply Outfit Planning principles to the repair of submarine tanks.

A typical submarine has approximately 60 tanks on board that perform a variety of functions such as liquid storage and control of the ship. During the overhaul period most tanks are opened, inspected, and repaired. Traditional methods of sequencing and controlling the repair functions in the tanks have not always been totally effective. Outfit Planning methods offer an alternative approach.

Outfit Planning in submarine tank repairs makes little use of pre-fabrication and pre-outfitting. A group-oriented approach to planning and executing work is used to bring together the right people to focus on specific phases of the work. Planning and Production personnel work together to implement usually obvious changes to streamline the work. Acting as a unit, the Group has considerable leverage to influence productivity.

The availability of computer data base management and project management software offers the possibility of developing better tools to track work status, predict work sequences, and predict work loads.

Computer Aided Design (CAD) systems are being used to model tank structure and systems to assist in

the preparation of Unit Work Procedures that specify how tank work is to be accomplished. The result is task level work planning in the form of work sequences and work procedures with input from appropriate trades.

Tank repair using Outfit Planning concepts involves the use of these tools to manage and execute tank work.

### INTRODUCTION

Puget Sound Naval Shipyard has been involved in using Outfit Planning and Zone Logic principles for several years (1). Initially, these efforts were focused on shipalts which involved the installation of new systems or new equipment and offered opportunities for prefabrication and pre-outfitting. Naval Shipyards also do a great deal of repair and refurbishment work on existing components. A typical submarine overhaul requires approximately 160,000 mandays of effort. About one half of that is repair work. Puget Sound Naval Shipyard is pursuing the use of the same techniques to plan and accomplish repair work.

U.S. Naval Shipyards are traditional functional organizations, i.e., people, information, and work are grouped by ships systems (2). This type of organization is best suited to the production of uniform products. A Naval Shipyard's workload, however, is characterized by a variety of products built in variable quantities. This inconsistency between organization and function results in systemic problems that inhibit productivity. Two problems characteristic of function-oriented shipyards are:

1. Poor interdepartmental communication.
2. Work packages that are too large to allow control of material, manhours, and schedule (3).

In the area of shipalt work, Outfit Planning concepts have been effective in increasing productivity through the use of ad hoc committees that focus on products within zones in lieu of systems. Since the Shipyard handles repair work much the same as shipalt work, it follows that there is benefit in applying the same Zone Logic. It is the planning methodology that is important. This is where Puget Sound Naval Shipyard is concentrating its efforts.

Historically, the Shipyard has done a good job of completing submarine tank work to support undocking, but frequently only as a result of some significant eleventh hour heroics on the part of the production workers. A typical submarine undocking is preceded by intense tank work activity to meet schedule. Since the Shipyard's performance is judged by its ability to meet undocking dates, one is left wondering if there isn't a better way to manage tank work that provides more positive assurance of schedule adherence. The recurrence of this feeling at the Shipyard management level has resulted in the formation of an Outfit Planning group to improve the tank repair process.

#### THE OUTFIT PLANNING GROUP

Initiation of an Outfit Planning group was accomplished by the appointment of a Group Chairman from the Planning Department and a Zone Manager from the Production Department. These two individuals organized a core group of representatives from areas of the Shipyard most involved in the tank repair process. The areas represented were:

1. Design
2. Planning and Estimating
3. Scheduling
4. Test Engineering
5. Combat Systems
6. Pipefitters
7. Shipfitters
8. Machinists
9. Sandblasters and Painters

A period of time was required to orient and educate the group members in the concepts of Zone Logic. At the beginning of the Group's activity, meetings were held twice a week. The Group familiarized itself with Outfit Planning concepts and with the activities of previously established groups while it struggled with the problem of tank repairs. Immediately there were obvious differences between this project and the shipalt projects previously done. Prefabrication and pre-outfitting are basically not involved in tank repairs. Material

requirements are centered around fixing what already exists. The ship cannot as easily be broken into large blocks as is done with shipalt work. Tanks naturally define many small zones that can be treated separately or as groups. Zone boundaries must be defined for piping systems that interface with tanks so that all work relating to tank testing can be included.

It was clear that this would be a different use of the Outfit Planning concept. However, some tools were still available to the Group. A fundamental part of any Outfit Planning activity is the group-oriented approach which integrates the basic functions of planning and production. A fresh approach to old problems is more likely to develop in an atmosphere that encourages group synergy. Unit work procedures were also seen as a tool for executing repair work. A critical step for the Group was the establishment of a clear-cut objective followed by a plan of action and milestones. Having done this, the Group set to work on implementing the plan.

#### TANK REPAIR WORK - THE PROBLEM

The attention of the Group was initially focused on isolating the problems that result in a lack of complete control of the tank repair process. A search for problem tanks and problem tank evolutions did not expose any obvious areas where intensified efforts would improve productivity. The problem of tank repairs centers more around the multitude of tasks<sup>1</sup> that need to be done in order to complete the job. In general, tank work involves the following steps:

1. Take custody of the tank
2. Open tank
3. Clean
4. Inspect
5. Repair
6. Preserve
7. Close
8. Test
9. Return tank to ship custody

Consider that these nine evolutions are required for most of the approximately 60 tanks on a typical submarine and you have a minimum of 600 tasks to manage. This figure

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<sup>1</sup> The word "task," as used in the Outfit Planning context, is defined as an element of work, performed by a single trade or skill that can be accomplished without interruption.

does not include tasks associated with shipalt work nor does it attempt to itemize all of the inspection and repair items that might be involved. The actual number of tasks to be managed is closer to 1500. Authorization to accomplish the work, in the form of job orders, does not identify these individual tasks, but instead gives a generic description of work. Scheduling relates job orders to schedule events that they must support. All task level work list development and scheduling is done at the worker level. The Shipfitter General Foreman assigns the tank management responsibility to a mechanic who is known as a Tank Coordinator. It is that person's job to coordinate all tank work such that schedule dates are met. Tools and methods are at the option of the Tank Coordinator. In the past, some have used computers to keep lists of things to do, but the primary management tool has been the wall chart. A great deal of dependence is placed on the skills of the individual Tank Coordinator.

Based on the above, the Outfit Planning Group determined that the tank repair problem was a process oriented problem and that better management tools were needed to manage those processes. A second but related problem identified by the Group was the lack of work instructions specifically for tank repair tasks. Certainly not every task needs an instruction for each tank, but there are those that would benefit. Tasks that the Group felt would benefit from more specific instructions are:

1. Initial inspections
2. Tank testing
3. Returning tanks to ship custody

#### OUTFIT PLANNING TANK REPAIR WORK

##### Tank Repair Project Management

Having identified a group of problems related to a lack of tools to manage tank work, the Group set about providing some tools. The first priority was to plan and sequence tank work at the task level. Lists of work items necessary to accomplish tank work have been used for some time, but time frames for execution of the task had not been put on paper. Generation and maintenance of a schedule for 1500 tasks would be impractical if done by hand. The obvious solution was a computerized Project Management system similar to those commercially available such as MS Project, Super Project, etc. Project Management software provides for the development of a data base consisting

of tasks, durations, and dates. It allows a variety of outputs such as Pert charts, Gantt charts, and resource details to be extracted. Dependencies of one task on another are accounted for.

The Outfit Planning Group decided to use a Shipyard-developed program named "Quicksched" to develop and manage the tank work data base for its first project. This program was chosen because it provided a variable format output that could be tailored to the Shipyard's needs. Data input for the first ship project was done by hand, one tank at a time. A list of repair tasks for each tank was prepared and sequenced in order of execution. In some cases, tasks were grouped together and assigned a common time frame if the sequence of execution was not important. The program software is able to identify the window for execution of a task and also the duration of the task.

In cases where sequencing was important, dependencies between tasks were entered. A sandblast sequence developed by the Outfit Planning Group was the basis for sequencing initial tasks in a tank. Previously established sequences for Special Hull Treatment application, tank testing, and other key events were used to define other task sequences and completion dates. Identification of durations for each task proved to be the most difficult part of the job. Historically, the Shipyard authorizes work in such large packages, both in manhours and in calendar time, that using cost return data to establish manhours required to complete an individual task was not possible. The Shipyard corporate knowledge about how long it takes to do work resides mostly in the heads of experienced production personnel. The Outfit Planning Group used that source to establish task durations. Figure 1 is a sample tank work sequence similar to that developed for each tank.

After completing the Quicksched data base and going through a review and revision cycle, the data base was installed on a PC computer in the dockside office of the ship's Tank Coordinator. This person is the data base custodian. At this point, the Tank Coordinator gained the following advantages:

1. Lists of tasks could be easily maintained and grouped by tank or by trade.
2. Windows for accomplishment of tasks could be easily identified.
3. The ramifications of change

USS GEMERIC SSN-000 TANK "BALLAST 1"																						
SEQ	TANK	TASK DESCRIPTION	SHOP / GEN FON	START	COMPLETE	EVENT	REMARKS	21	28	4	11	18	25	2	9	16	23	30	6	13	20	27
1	BALLAST 1	OPEN WORK PERMIT	S/11 & C/330	8/17/87	8/17/87	0001	SUBMITTED PRIOR TO SHIP ARRIVAL															
2	BALLAST 1	OPEN TANK	S/11	8/17/87	8/17/87	0001																
3	BALLAST 1	SAFETY INSPECTION	S/11 & C/105	8/17/87	8/18/87	0001	GAS FREE & RADIATION SURVEY															
4	BALLAST 1	INITIAL CLEANING	S/72 CLEANERS	8/18/87	8/19/87	0001																
5	BALLAST 1	INITIAL INSPECTION	COGNIZANT SHOPS	8/19/87	8/28/87	0001	SUBMIT INSPECTION REPORT TO S/11															
6	BALLAST 1	REMOVE ELECTRICAL ITEMS	S/51	8/20/87	8/25/87	0002	TANK LEVEL INDICATOR & CABLES															
7	BALLAST 1	REMOVE MECHANICAL ITEMS	S/38	8/21/87	8/27/87	0002	BLOW VALVES & VENT VALVES															
8	BALLAST 1	REMOVE PIPING ITEMS	S/56	8/24/87	8/29/87	0002	INTERFERENCES															
9	BALLAST 1	REMOVE STRUCTURAL ITEMS	S/11 & S/26	8/20/87	9/1/87	0002	TEMPORARY ACCESSSES															
10	BALLAST 1	REMOVE LEAD BALLAST	S/11	8/26/87	9/1/87	0002	HEALTH HAZARD (COORD WITH OSHA)															
11	BALLAST 1	SURVEILLANCE	S/11 & C/135	9/1/87	9/24/87	0003	ULTRASONIC TEST OF STRUCT. WELDS															
12	BALLAST 1	INSTALL SANDBLAST PROTECTION	COGNIZANT SHOPS	9/1/87	9/3/87	0003																
13	BALLAST 1	SANDBLAST	S/71 BLASTERS	9/3/87	9/10/87	0003																
14	BALLAST 1	SURVEY INSPECTION	C/250.4 & S/11	9/10/87	9/11/87	0003	PREPARE DOCUMENT TO SHOW REPAIRS															
15	BALLAST 1	PAINT	S/71 PAINTERS	9/11/87	9/18/87	0003	ALL COATS															
16	BALLAST 1	SURVEY REPAIRS	S/11 & S/26	9/18/87	10/8/87	0003	WELD & GRIND DETRIMENTATION															
17	BALLAST 1	REPAIR MECHANICAL ITEMS	S/38	9/22/87	10/8/87	0003	VENT VALVE SEAT & LINKAGES															
18	BALLAST 1	REPAIR PIPING ITEMS	S/56	9/28/87	10/13/87	0003	PER INITIAL INSPECTION FINDINGS															
19	BALLAST 1	RESTORE STRUCTURE	S/11 & S/26	10/8/87	10/26/87	0004	ACCESSSES AND INTERFERENCES															
20	BALLAST 1	RESTORE PIPING SYSTEMS	S/56	10/13/87	10/22/87	0004																
21	BALLAST 1	RESTORE MECHANICAL SYSTEMS	S/38	10/14/87	10/22/87	0004																
22	BALLAST 1	RESTORE ELECTRICAL SYSTEMS	S/51	10/16/87	10/28/87	0004	REPLACE INTERFERENCE REMOVALS															
23	BALLAST 1	FLUSH PIPING	S/56 TESTERS	10/22/87	10/29/87	0005	TO RESTORE CLEANNELINESS															
24	BALLAST 1	TEST PIPING SYSTEMS	S/56 TESTERS	10/27/87	11/10/87	0005	STRENGTH & TIGHTNESS															
25	BALLAST 1	TEST ELECTRICAL SYSTEMS	S/51 & S/67	11/2/87	11/10/87	0005																
26	BALLAST 1	TEST MECHANICAL SYSTEMS	S/38	11/4/87	11/10/87	0005	STRENGTH & TIGHTNESS															
27	BALLAST 1	INSTALL LEAD BALLAST	S/11 & S/72	10/26/87	11/10/87	0005	HEALTH HAZARD (COORD WITH OSHA)															
28	BALLAST 1	TEST STRUCTURAL TIGHTNESS	S/11 TESTERS	11/9/87	11/11/87	0005																
29	BALLAST 1	TOUCH-UP PAINT	S/71 PAINTERS	11/10/87	11/12/87	0006																
30	BALLAST 1	FINAL NOISE SURVEY	C/260	11/12/87	11/12/87	0006	VIBRATION AND SOUND ISOLATION															
31	BALLAST 1	FINAL NAVSEA INSPECTION	C/191	11/12/87	11/12/87	0006																
32	BALLAST 1	FINAL CLEAN	S/72 CLEANERS	11/12/87	11/13/87	0006																
33	BALLAST 1	FINAL RECORDS CHECK	C/136 & C/365	11/12/87	11/13/87	0006																
34	BALLAST 1	CERTIFY WORK COMPLETE	COGNIZANT SHOPS	11/13/87	11/13/87	0006																
35	BALLAST 1	FINAL SHIPFORCE INSPECTION	S/11 & SHIP	11/13/87	11/13/87	0006	ACCEPTANCE DOCUMENTATION REQ'D															
36	BALLAST 1	CLOSE TANK	S/11	11/13/87	11/13/87	0007																
37	BALLAST 1	FINAL SYSTEM TESTS	COGNIZANT SHOPS	11/13/87	12/4/87	0007	OPERATIONAL TESTING															
38	BALLAST 1	CLOSE WORK PERMIT	S/11 & C/330	11/13/87	11/13/87	0007																

BLANKET

PAGE 1

FIGURE 1. SAMPLE TANK REPORT

4. The status of work was easily identified.
5. Status reports could be easily generated to suit management.
6. Critical path evolutions were highlighted by the software.
7. Corporate knowledge of "as accomplished" work sequences and durations was easier to retain.
8. Priorities for work permits to open tanks were easier to identify and provide for Ship's Force action.
9. Trade interference and competition for space were reduced.

At the date of this writing, the reaction of the top level Production management is to direct that tank repair work sequences, known as tank reports, be developed for all submarines in the Shipyard. Some of these ship overhauls were already in danger of missing schedule dates because of tank work. The tank managers for these ships adopted the tank report as a tool to minimize schedule impact. From a manager's point of view, the tank report repre-

sents a detailed plan of action to achieve schedule dates. Previously, the production working level plan to achieve schedule adherence was not all that visible to upper management. The result is a rapidly expanding program to provide project management data bases for all Shipyard tank work and all other work leading to the undocking of ships.

This Shipyard's efforts to implement project management on a large scale will impose some additional problems. The Outfit Planning Group started on a limited scale using desk top computer hardware. The purpose was to provide a tool for waterfront managers to do their jobs more effectively. Those who were involved were computer literate. The success of a computerized task management system requires dedicated personnel to provide continual attention to the data base so that current information is always available. The software must be suitable to mainframe computer systems that are likely to be in place to manage a Shipyard-wide management data base. Being restricted to PC based systems will limit the ultimate utility of the project.

Procedures and software must be made

user friendly so that special skills are not required for users to be successful. The software system used must be capable of handling large data bases, must have flexibility in output format, and must be able to communicate with other related software systems for spread sheets, data base management, and graphics production.

Finally, there exists a potential that those who monitor production will use the system to tell them if production is on track or not. If this happens on a wide scale, then the data base will come to reflect what upper management wants to hear while waterfront managers use old style methods to solve problems before upper management finds out there is a problem. This tool should be used to support tank coordinators. Management should develop its own indicators of performance that are not controlled by the people doing the work (4).

#### Tank Repair Unit Work Procedures

A second major area of concern to the Outfit Planning Group was the lack of specific instructions for accomplishing tank repair work. The Tank Coordinators felt that a more structured approach would cause a more uniform response on the part of all production trades and thus make the job of managing tank work easier. Initial inspection of tank systems and equipment was thought to be a good place to begin because the Shipyard has historically had problems in this area. The total extent of the repair package for a boat is not known until these inspections are done. Obviously that cannot happen until sometime after docking. The best that can be achieved is to identify the repairs as early in the overhaul as possible. This is necessary both to identify costs and to integrate the repair work into other overhaul activities. The Tank Coordinator is primarily responsible for this but must rely on other trades to inspect their systems in the tanks and report required repairs. Guidelines for these inspections either do not exist or are contained in a variety of Shipyard instructions. Consequently the effectiveness of the inspections is not consistent and required repairs are sometimes not identified until late in the overhaul.

To deal with this situation, the Outfit Planning Group has initiated the development of Unit Work Procedures, as was done by previous Outfit Planning Groups for shipalts (5). These work procedures identify what must be inspected, what acceptance

criteria apply, and specify a reporting procedure to be followed. The procedures are formatted so that each trade's inspections are grouped together. All inspections that can be done at that time during the overhaul are listed to insure that the necessity to reenter the tank will be reduced. In cases where location of the items to be inspected is not clear, graphics are provided to define locations. Figures 2 through 4 are excerpts from a prototype unit work procedure. The intention is to insure that all required inspections are accomplished and repairs are identified as early as possible during the overhaul.

Having the procedure defined in writing at the task level helps accomplish this because it defines the work that must be done in a relatively small package that makes it easy for production workers to sequence, manage, and report completion of tasks. When the work is completed, expenditures can be collected and reported back to Planning and Estimating to establish corporate history of costs at the task level. This information will provide a basis for better estimates for future work and will help to establish control limits for monitoring work in the future. A side benefit of using unit work procedures to specify initial inspection is that identification of required repairs is much easier in case the Shipyard and the Ship's Force disagree on what must be repaired.

#### Tank Structural Repairs

A related but separate project being pursued by the Tank Outfit Planning Group involves the development of improved ways for Design to communicate tank structural repairs to the shop based on Design's visual survey. Figures 5 and 6 show examples of tank structural deterioration. Narrative descriptions of the repairs have been used in the past. This method has been satisfactory but leaves much room for interpretation on the part of the Production worker and is time consuming for Design to produce. The intent is to reduce the preparation time and clarify the instruction by using a graphical approach to specify repairs. The key to this idea is to be able to rapidly generate graphics of tank structure as needed. CAD computers are a possible solution.

At present, CAD models of the aft trim tank and depth control tank structure on an SSN 637 Class submarine have been modeled on a CAD

## UNIT WORK PROCEDURE

SHIP/PROJECT		WORK PKG ZONE UWP ZONE		UWP NO.		REV	
		INTERIOR AFT TRIM TANK		113-A03			
SHOP	WORK CTR	MAT'L LANDING DATE	START DATE	COMP DATE	ZONE MANAGER		
		N/A			FLAVIN S/II		
PREPARED BY		SHOP PLANNER	PHONE	COMPLETION CERTIFICATION			
LEAVERTON S/II LOFT		MODUN	6-2315				

THIS UNIT WORK PROCEDURE SPECIFIES INITIAL VISUAL INSPECTIONS TO BE ACCOMPLISHED IN THE AFT TRIM TANK. THE INTENT OF THESE INSPECTIONS IS TO ESTABLISH EXISTING CONDITIONS AND TO IDENTIFY REPAIRS TO SYSTEMS IN THE TANK.

SHOPS AFFECTED: 11,56,51&71.

THE FOLLOWING SYSTEMS & COMPONENTS ARE EXISTING IN THE TANK AND REQUIRE INITIAL INSPECTION:

1. TRIM SYSTEM FILL & SUCTION PIPE.
2. GRAVITY DRAIN PPG (THIS PPG ROUTES THRU THE TANK).
3. TANK LEVEL INDICATING SYSTEM-ELECTRICAL.
4. TANK TOP PENETRATION FOR PRESSURE RELIEF PPG.
5. TANK TOP PENETRATION FOR CHARGING SYSTEM PPG.
6. ZINCS.
7. PAINT.
8. BOILER TYPE MANHOLE COVER, SEAT & GASKET.

ATTACHED ARE "INITIAL INSPECTION REPORT" FORMS PER SHOPS AFFECTED.

ALL SHOPS:

1. COMPLETE "INITIAL INSPECTION REPORT" FORM.
2. SEND COPY TO S/II TANK COORDINATOR.
3. ROUTE FORM TO P & E BY PAR IF FUNDING FOR REPAIRS IS REQUIRED.
4. REVIEW TANK REPORT SEQUENCES & DURATIONS AND GIVE S/II TANK COORDINATOR UP DATE INFO BASED ON THE CONDITION FOUND.

PRECAUTIONS:

1. DO NOT ATTEMPT TO PERFORM THE INSPECTIONS OF THIS UWP UNTIL INFORMED BY S/II TANK COORDINATOR THAT THE TANK IS READY FOR INSPECTION.
2. INSURE THAT THE GAS FREE CERTIFICATION IS CURRENT & SPECIFIES "SAFE FOR ENTRY" BEFORE ENTERING THE TANK. (IPT 0010-641)
3. OBSERVE SAFETY PRECAUTIONS OF OSH MANUAL 5100.56 WHILE PERFORMING INSPECTIONS.

DRAWINGS

JOB ORDERS

CERTIFICATION (INCLUDE DATE)		LOFT		PLANNING		SHOP		WATERFRONT	
COPIES									
ROUTING		SHOP PLT	SHOP MACH	SHOP	SHOP	SHOP	SHOP	SHOP	TOTAL
		PLG L.O.	L.O. FOR	FOR	FOR	FOR	FOR	FOR	ISSUE

FIGURE 2.

SAMPLE UNIT WORK PROCEDURE

## UNIT WORK PROCEDURE

(CONTINUATION SHEET)

SHIP/PROJECT	UWP ZONE	UWP NO.	REV
	AFT TRIM	113-A03	

"INITIAL INSPECTION REPORT"

S/II

INSPECT STRUCTURE, PPG & ELECTRICAL PENETRATIONS, WASTER PLT, MANHOLE COVER, SEAT AND GASKET FOR THE FOLLOWING CONDITIONS:

SAT	UNSAT	
		1. STRUCTURE MATERIAL DETERIORATION.
		2. STRUCTURE MATERIAL DEFORMATION.
		3. WELOS FOR VISUAL DEFECTS AND COMPLETENESS.
		4. COVER GASKET FOR CUTS, TEARS, HARDENING, AGE CRACKS, WORN AREAS, PERMANENT SET, PAINT, RUST, OIL, GREASE, OR OTHER DAMAGE/DETERIORATION, (PI 0167-019 ADDENDUM C1).
		5. COVER SEATING SURFACE FOR NICKS, GOUGES, SCRATCHES OR CORROSION THAT WILL PERMIT LEAKAGE. (PI 0167-019 ADDENDUM C1).
		6. STRONGBACK ASSEMBLY FOR EXCESSIVE WEAR OR CORROSION & PROPER INSTALLATION. (PI 0167-019 ADDENDUM C1).
		7. LOCKING DEWISE IS "U" TYPE, SEE FIGURE C-7 (PI 0167-019 ADDENDUM C1).
		8. HINGE ASSEMBLY FOR WEAR & CORROSION. (PI 0167-019 ADDENDUM C1).
		9. MANHOLE INSTALLED PER FIG (PI 0167-019 ADDENDUM C1).
		10. TLI CABLE STUD RUNS FOR DAMAGED STUDS.
		11. TLI FDS FOR DAMAGE.

NOTE: 1. MANHOLE INSPECTION RESULTS SHALL BE REPORTED TO C/231 ON FORM 4730/236.  
2. PERFORM ZINC SURVEY OF SECT. III.1 OF SSN669-633-DM513444 IN CONJUNCTION WITH ABOVE INSPECTIONS.

FIGURE 3.

SAMPLE UNIT WORK PROCEDURE

UNIT WORK PROCEDURE (CONTINUATION SHEET)			
SHIP/PROJECT	URP ZONE AFT TRIM	URP NO. 113-A03	REV

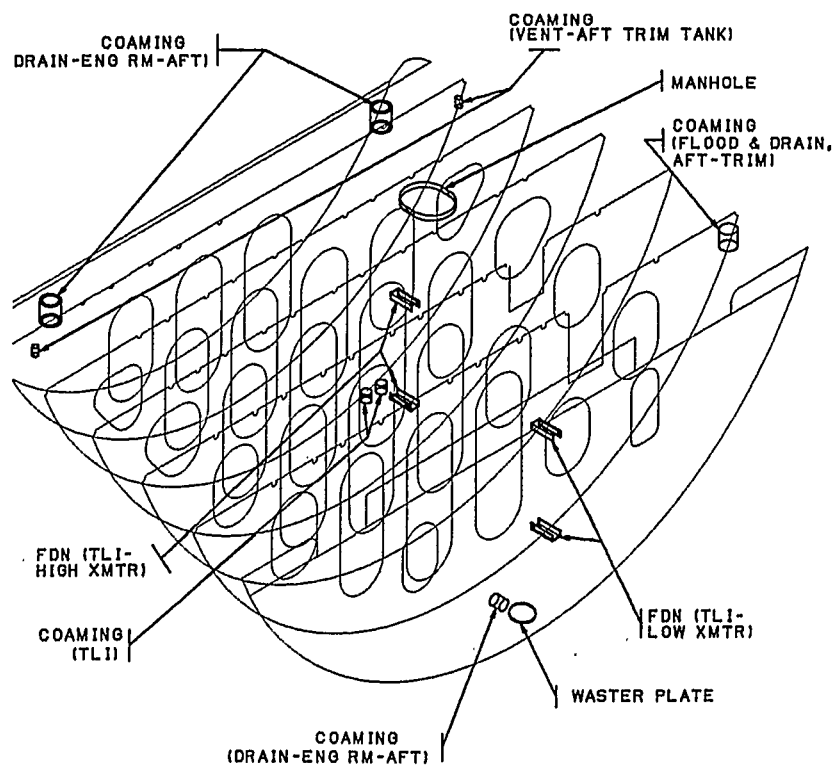


FIGURE 4.  
SAMPLE UNIT WORK PROCEDURE



FIGURE 5.  
BALLAST TANK LEAD POCKET -  
HULL PLATING CORROSION  
ELEVATION VIEW - LKG INBD



FIGURE 6. DIESEL EXHAUST ENCLOSURE -  
STRUCTURAL DETERIORATION

system and are being used to provide the graphics for specifying repairs. Use of CAD generated graphics to prepare repair instructions is resulting in an estimated document preparation time savings of about 30 to 40 percent. Time saved in locating and laying out the repair work on board ship is estimated to be about 25 percent. Cost of the CAD modeling is about 5 to 10 mandays per tank. Clearly, this method is a benefit to tank work, but is costly to implement. The positive returns on the CAD investment come from developing all potential uses for the models, such as the preparation of quality control forms, and reuse of the models on all future ships of the same class. This return can be expedited by modeling

only tanks which have a high incidence of repairs. Certainly, other Shipyards can utilize the tank models for similar purposes.

#### CONCLUSION

To date the Shipyard has used Outfit Planning to prepare for repair work in the areas of Special Hull Treatment and Main Sea Water Bay as well as tank repairs. A large group of Shipyard workers has been involved at one time or another. The general consensus of these people is that their participation in Outfit Planning has had a positive effect on productivity. The Production workers are encouraged by their opportunity to participate in planning for work they

will execute. The feeling is that getting the right personnel involved in a group-oriented planning activity is much better than the normal procedure which separates Planning and Production functions.

The Shipyard is now enjoying some of the benefits of Outfit Planning in the repair portion of its work. Among these benefits are:

1. Breakdown of communication barriers between Planning and Production and also between system-oriented Production Trades.
2. Identification of work sequences in advance of ships arrival.
3. Introduction of smarter work methods.
4. Reduction of reference material at the Production working level.

These benefits contribute to the Outfit Planning Group's short term goal of increasing tank repair efficiencies so that schedule is not impacted. Much of the early emphasis was on getting work done on time in lieu of saving money.

Breaking the benefits into dollars saved is a difficult task under the current fund management system and is premature at this time. The Shipyard's Industrial Engineering organization has undertaken studies to identify cost savings for some Outfit Planning efforts (6). A similar study will be necessary to identify and document savings from Tank Repair Outfit Planning. The authors feel that if such a study were done in the near future that a 10 to 20 percent savings in manhours would be identified in addition to a significant improvement in control of tank work.

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